



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Yamaguchi, et al.

Serial No.: 10/087,556

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For: Semiconductor Device and Bump Formation Method

Conf. No.: 2191

Docket No.: TI-31471

Examiner: Im, J. M.

Art Unit: 2811

**Supplemental Appeal Brief**

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Jay M. Cantor

Dear Sir:

Pursuant to the reopening of prosecution dated November 28, 2003, in order to avoid confusion in view of the removal of issues on appeal and the addition of an issue as to claim 2, this Supplemental Appeal Brief contains all pertinent arguments from the Brief on Appeal as they apply to the retained issues and also an argument as to the newly presented issued on appeal.

**Real Party in Interest**

The real party in interest is Texas Instruments Incorporated.

### **Related Appeals and Interferences**

No related appeals or interferences are known to Appellant.

### **Status of Claims**

Claims 1-6 and 9-22 are pending and are the subject of this appeal. Claims 7 and 8 have been cancelled.

### **Status of Amendments**

All amendments have been entered.

### **Summary of Invention**

One embodiment of the invention is a semiconductor device, which includes a contact pad (12 in Figure 1) on a semiconductor substrate 10 and a conductive bump 14 on the contact pad. The bump includes a coaxially-aligned stack of bodies 14a, 14b having different cross-sectional dimensions, the bodies at the top of the stack having smaller cross-sectional dimensions. See Figure 1 and paragraph [0029] of the instant specification.

Another embodiment of the invention is a semiconductor device which includes a contact pad (12 in Figure 1) on an insulating film on a semiconductor substrate 10; a barrier layer 16 on the contact pad; a first bump 14a on the barrier layer having a first cross-sectional dimension; and a second bump 14b on and coaxially aligned with the first bump. The second bump has a cross-

sectional dimension smaller than the first cross-sectional dimension. See Figure 1 as well as the text in paragraph [0030] of the instant specification.

Still another embodiment of the invention is a semiconductor device including a semiconductor substrate (10 in Figure 3A). The substrate 10 includes a contact pad 12; a first bump 14a on the contact pad; a smaller second bump 14b on the first bump, said second bump coaxially aligned with said first bump and having a substantially flat peak plane. The device further includes a printed circuit board 22, wherein the semiconductor substrate is mounted over the printed circuit board such that the contact pad and the first and second bumps are aligned with a conductive film 24 on the printed circuit board. See Figure 3A and the accompanying text in paragraph [0033] of the instant specification.

### **Issues**

1. Whether claims 1, 3-6, 9, 11, 12, and 18-22 are patentable under 35 U.S.C. 102(e) over Kanda, et al. (U.S. 6,153,938).
2. Whether claim 2 is patentable over Kanda in view of Murakami (U.S. 5,874,780).
3. Whether Claims 10, 12, and 13-17 are patentable under 35 U.S.C. 103(a) over Kanda in view of Lin (U.S. Patent No. 6,426,556).

### **Grouping of Claims**

Claims 1-6 and 9-22 stand or fall together.

## **Argument**

**Issue 1.** Claims 1, 3-6, 9, 11, 12, and 18-22 are patentable under 35 U.S.C. 102(e) over Kanda, et al. (U.S. 6,153,938).

Claim 1 includes the feature of "a conductive bump on said contact pad, said bump comprising a coaxially-aligned stack of bodies having different cross-sectional dimensions." Kanda does not teach a stack of bodies. In fact, Kanda describes exactly what is stated to be the prior art in Fig. 8 and the specification in paragraphs [0003] to [0006] of the subject application. The invention herein is precisely for the purpose of overcoming the shortcomings of the prior art as exemplified by Kanda as well as Fig. 8 of the subject application.

For example, it is clear from Kanda's Figure 3 and the accompanying description in col. 6, lines 1-13 that bump 2 and nipple 40 are a single body and therefore cannot be a stack of bodies. It is clear that the bumps 2 and pointed nipple 40 of Kanda are formed from a single application of the capillary to the bond pad as explained in paragraph [0003] of the subject application. In the subject specification, Appellant distinguishes the claimed invention from the type of structure described by Kanda. In particular, the disadvantages of the type of bump taught by Kanda are described in the "Background of the Invention" section of the instant specification paragraphs [0002] to [0010]. Therefore, Appellant submits that Claim 1 and Claims 2-6, 9, 11, and 12 depending therefrom are patentable over Kanda.

Claim 18 includes the features of "a first bump on said contact pad; a smaller second bump on said first bump, said second bump coaxially aligned with said first bump and having a substantially flat peak plane." As indicated above, Kanda does not teach more than one bump and therefore cannot teach a second bump coaxially aligned with a first bump. Therefore, Appellant submits that Claim 18 and Claims 19-22 depending therefrom are patentable over Kanda.

**Issue 2.** Claim 2 is patentable under 35 U.S.C. 103(a) over Kanda in view of Murakami (U.S. Patent No. 5,874,780).

Claim 2 depends from claim 1 and therefore defines patentably over the applied references for the reasons presented above with reference to claim 1 since Murakami does not and was not applied to overcome the shortcomings of Kanda with respect to claim 1.

**Issue 3.** Claims 10, 12, and 13-17 are patentable under 35 U.S.C. 103(a) over Kanda in view of Lin (U.S. Patent No. 6,426,556).

Claims 10 and 12 depend from Claim 1. As indicated above, Kanda fails to teach or suggest all of the features of Claim 1. Lin, cited for its alleged teaching of a barrier layer and an insulating layer, fails to cure the deficiency of Kanda with regard to the coaxially-aligned stack of bodies described in Claim 1. Since the combination of Kanda and Lin is deficient in teaching or suggesting all of the features of the claimed invention, Appellant submits that Claim 1, as well

as Claims 10 and 12 which depend therefrom, are patentable over the combination of Kanda and Lin.

Claim 13 includes the feature of a "first bump on said barrier layer having a first cross-sectional dimension; a second bump on and coaxially aligned with said first bump." Neither Kanda nor Lin teach or suggest such first and second bumps. Therefore, the combination of these references is deficient in teaching or suggesting all of the features of the claimed invention. Claims 14-17 depend from Claim 13. Therefore, Appellant respectfully submits that Claims 13-17 are patentable over Kanda in view of Lin.

### **Conclusions**

In view of the above, Appellant appeals for the reversal of the rejections and allowance of Claims 1-6 and 9-22.

Respectfully submitted,



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## **APPENDIX**

### **Claims on Appeal**

1. A semiconductor device, comprising:
  - a contact pad on a semiconductor substrate;
  - a conductive bump on said contact pad, said bump comprising a coaxially-aligned stack of bodies having different cross-sectional dimensions, said bodies at the top of said stack having smaller cross-sectional dimensions.
2. The semiconductor device described in Claim 1 in which the uppermost body in said stack has a flat peak plane.
3. The semiconductor device described in Claim 1 in which the coaxially-aligned bodies are circular.
4. The semiconductor device described in Claim 1 in which the bodies are made of gold.
5. The semiconductor device described in Claim 2 in which the bodies are made of gold.
6. The semiconductor device described in Claim 3 in which the bodies are made of gold.

9. The semiconductor device of Claim 1, wherein said bodies at the top of said stack have a smaller height dimension than lower bodies in said stack.

10. The semiconductor device of Claim 1, further comprising a barrier layer between said conductive bump and said contact pad.

11. The semiconductor device of Claim 1, further comprising a passivating film around said contact pad.

12. The semiconductor device of Claim 1, wherein said contact pad is on an insulating film on said semiconductor substrate.

13. A semiconductor device, comprising:

- a contact pad on an insulating film on a semiconductor substrate;
- a barrier layer on said contact pad;
- a first bump on said barrier layer having a first cross-sectional dimension;
- a second bump on and coaxially aligned with said first bump, said second bump having a cross-sectional dimension smaller than said first cross-sectional dimension.

14. The semiconductor device of Claim 13, further comprising a passivating film around said contact pad.



15. The semiconductor device of Claim 13, wherein said first bump has a first height dimension and said second bump has a second height dimension, wherein said first height dimension is greater than said second height dimension.

16. The semiconductor device of Claim 13, wherein said first and second bumps are circular.

17. The semiconductor device of Claim 13, wherein said bumps are made of gold.

18. A semiconductor device, comprising:

- a semiconductor substrate, said substrate including:

- a contact pad on said semiconductor substrate;

- a first bump on said contact pad;

- a smaller second bump on said first bump, said second bump coaxially aligned with said first bump and having a substantially flat peak plane;

- a printed circuit board, wherein said semiconductor substrate is mounted over said printed circuit board such that said contact pad and said first and second bumps are aligned with a conductive film on said printed circuit board.

19. The semiconductor device of Claim 18, further comprising a passivating film around said contact pad.

20. The semiconductor device of Claim 18, wherein said first bump has a first height dimension and said second bump has a second height dimension, wherein said first height dimension is greater than said second height dimension.

21. The semiconductor device of Claim 18, wherein said first and second bumps are circular.

22. The semiconductor device of Claim 18, wherein said bumps are made of gold.